The Meteorological Magazine

Air Ministry :: Meteorological Office

Vol. 59
August 1924
No. 703

LONDON: PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE

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On Rainfall of very Rare Intensity

By F. J. W. WHIPPLE, M.A., F.Inst.P.

THE storms in which exceedingly heavy rainfall occurs are of great interest not only to the witnesses and victims, but also to the engineers who have to make provision for carrying away excessive flood water and to the physicists who speculate on the mechanism by which the rainfall is produced. Since 1868 a section of *British Rainfall* has been devoted to "Heavy Rains in Short Periods." Correspondents have occasionally shown scepticism with regard to the validity of the entries in this table, and have been able to point out that some, at any rate, depended on comparatively rough estimates of the amount of rain or of the time during which it fell. Perhaps insufficient stress has been laid on the fact that one set of observations existed which could be regarded as a standard of reference, in that, whilst the intensities had seldom been surpassed, the record was made with appropriate apparatus. As far as I know, there is no autographic rain-gauge in existence such that time can be read to within a few seconds: if we want to learn how much rain can fall in a minute we must be able to estimate the time with precision. Symons turned the difficulty by trusting to direct observations of the movement of a float. From *British Rainfall* 1877 we learn that it was in 1865 that he set up a storm rain-gauge "to show at a distance of 80 ft. the amount of fall, minute by minute." This gauge was found to have two drawbacks, the risk of damage in frosty weather and

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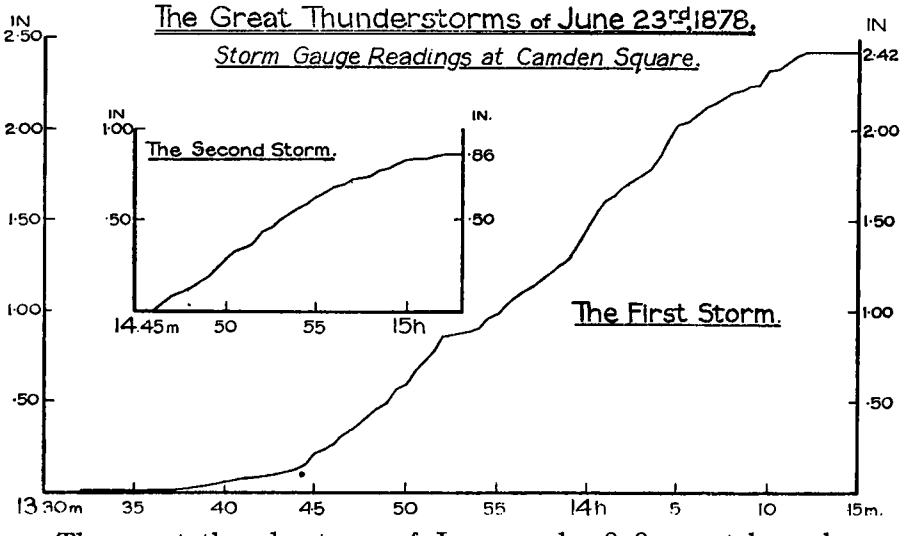
the difficulty of observing at night. In 1875 Symons' illuminated Storm Gauge was made by Pastorelli, and set up at Camden Square. With this gauge the amount of rainfall was shown by two hands on a dial, the little hand showing the number of inches, the big hand the hundredths. The movement of the big hand was controlled directly by a float: that of the little hand by gearing. When the gauge was in the garden at Camden Square the open scale could be read by the naked eye from the window of Symons' room. This gauge is now in the Science Museum. Whether any similar gauges are in use elsewhere, I do not know. There was one at the Bristol Docks in 1876.



The great thunderstorm of June 23rd, 1878, must have been one of the most severe that ever visited London. A map in *British Rainfall* 1878 shows how numerous were the buildings struck by lightning within a short distance from Camden Square. Observations were made with the storm gauge, generally at half-minute intervals. From the readings the graphs reproduced above have been drawn. There were actually two storms, separated by an interval of about half-an-hour. The first storm is the one which invites attention. It will be noticed that the rate at which the rain fell was fairly steady, but that occasional bursts of greater intensity lasted a minute or two. The largest amounts which were recorded in certain intervals are shown in the accompanying table.

It is curious to notice that the highest average rate for six minutes exceeds the highest for four or five minutes. This is because the six minutes can include two minutes each with 0·17 in., the minutes beginning at 1-59 and 2-5.

It is to be borne in mind that these statistics refer to a storm

of rain not of hail: there were hailstorms on the same day in other localities, but none seem to have been reported in North London.

Rainfall Recorded at Camden Square, June 23rd, 1878.

Interval.	From.	To.	Amount.	Mean Rate.
minutes.	h. m. s.	h. m. s.	ins.	in./hr.
½	2 4 0	2 4 30	0·10	12
1	2 3 30	2 4 30	0·17	10
1½	1 59 0	2 0 30	0·26	10
2	1 59 0	2 1 0	0·32	9·6
3	1 58 0	2 1 0	0·40	8·0
4	1 57 0	2 1 0	0·47	7·0
5	1 59 0	2 4 0	0·56	6·7
6	1 59 0	2 5 0	0·73	7·3
8	1 58 0	2 6 0	0·87	6·5
10	1 55 0	2 5 0	1·04	6·2
15	1 50 0	2 5 0	1·43	5·7
20	1 46 0	2 6 0	1·82	5·5
25	1 45 0	2 10 0	2·11	5·1
28	1 44 0	2 12 0	2·30	4·9
30	1 42 0	2 12 0	2·34	4·7

The preceding table provides a standard by which reports of heavy rain can be judged. It will be admitted that the intensity reached in London on June 23rd, 1878, might be equalled occasionally in any part of the United Kingdom as every part is subject to thunderstorms. It is remarkable, however, that there are very few occasions known on which the total rainfall for any interval up to half an hour has exceeded that measured on this day. For the half-hour the largest amount on record is 2.90 inch, which was reported at Ash Hall, Cowbridge, near Cardiff, on July 22nd, 1880. The Report (*British Rainfall* 1880, p. [16]) runs :—" 2.90 inch of rain fell in 30 minutes from 1.50 to 2.20 p.m., accompanied by an immense quantity of ice in irregular-shaped pieces measuring from ½ to ¾ inch in diameter."

For a much shorter interval we have one outstanding example of rainfall estimated as being at twice the Camden Square rate. This was at Preston on August 10th, 1893. The following details were given by Mr. Sydney Wilson, an observer with 14 years' experience, in *Symons's Meteorological Magazine*, September, 1893, p. 117. "At the Corporation Offices, where I was present at the time, 2.09 in. fell in the 35 minutes, 4.5 to 4.40 p.m. After much careful thought and consideration I submit the following as showing approximately how this fall of 2.09 in. was distributed over the 35 minutes, 4.5 to 4.40 :—

4. 5 to 4.25	·70	inch
4.25 to 4.29	·04	,,
4.29 to 4.34	1·25	,,
4.34 to 4.40	·10	,,
TOTAL	2·09	inch

I consider the amount 1·25 in the five minutes, 4.29 to 4.34 p.m., well within the mark and too little, if anything . . . The excessive rain (and hail) did damage in Preston to the extent of thousands of pounds . . . At Leyland, 4 miles south, there was no rain or storm at all."

This estimate of Mr. Wilson's must be admitted, I think. It gives us 15 inches an hour as the heaviest rainfall intensity on record for this country. Whether such a rate is much exceeded in what Espy used to call "Meteoric Rivers or Waterfalls" is a question on which judgment must be reserved.

The Thunderstorm of July 22nd, 1924

By E. G. BILHAM, B.Sc.

AMONG the numerous thunderstorms which occurred during the latter part of July the disturbance of Tuesday, July 22nd, was especially noteworthy. The remarkable hailstorm which visited the London area between 13h. 30m. and 14h. G.M.T. constituted one feature of special interest; another was the fact that ball-lightning was observed during the storm both at South Kensington, London, and at Woking; a third was the exceptional intensity of the precipitation. Before discussing the theoretical aspects of the storm a summary may be given of the more interesting observations which have been received. Attention will be confined to the disturbance associated with the London hailstorm. Thunderstorms occurred during the day in numerous districts not mentioned in this article, notably in Devonshire

and Derbyshire. It is not clear, however, that they were directly associated with the London storm, and space does not permit of their further consideration.

Air Ministry, Kingsway, W.C. 2. Rain began 13h. 15m.; heavy rain and hail 13h. 25m. to 13h. 55m.; total fall during the storm 19·7 mm. (0·78 in.). Hailstones of 0·7 in. and 0·8 in. diameter were measured; cut in half the stones showed no indication of stratification, they consisted of clear ice.

Meteorological Office, South Kensington. Rain began 13h. 30m.; 28 mm. (1·10 in.) fell in 20 minutes; total fall 32 mm. (1·26 in.) in 25 minutes, a record rate of fall for that period in London. 10 mm. (0·39 in.) were observed to fall in not more than 3 minutes. Just before 14h. temperature fell abruptly from 72° F. to 58° F.

Ball lightning was observed at 14h. 5m. Three balls were seen; they were close together and appeared the size of oranges. The edges were ill-defined and "fluffy" and the colour was a glistening white. The balls were observed to pass the second storey windows of the office in a due west direction and the speed was much slower than that of a flash of lightning, in fact the balls seemed to float past. Three peals of thunder followed which were of a short, explosive character.

The microbarograph, thermograph, anemograph and recording raingauge records are reproduced in Fig. 1.

Hampstead Observatory. Between 13h. 35m. and 13h. 40m. 12·7 mm. (0·5 in.) fell; between 13h. 40m. and 13h. 45m. 7·6 mm. (0·3 in.) were measured, total fall 37 mm. (1·44 in.). At the climax of the storm 9 mm. (0·36 in.) fell in 2½ minutes.

Southgate, N. 14. Rainfall between 13h. 35m. and 15h. 38 mm. (1·5 in.). Period of greatest intensity, 14h. to 14h. 45m., accompanied by vivid lightning and thunder following the flashes immediately.

A. S. RANSOME.

Woking. "During an extremely severe thunderstorm here this afternoon ball lightning was seen. It exploded with a deafening crash on a concrete paving cracking and splitting the surface over a radius of three feet. It was visible as a glowing ball some seconds before bursting. The thunder and lightning throughout the storm were remarkably severe. The storm commenced about 3 p.m. and lasted until 5 p.m."

E. C. RUTHERFORD.

Forest Hill and Purley. "Though still raining when the train left Cannon Street at 3.45 p.m. I was surprised on looking out at Forest Hill to see everything practically dry. At Purley there had been continuous thunder about mid-day. Lander & Smith's recording thermometer showed soon after 12 o'clock a rapid fall from 73° to 59°. Yet hardly any rain fell. The total for the 24 hours of 0·03 in. included some soon after 7 p.m.

"On reaching Purley at 4.15 p.m. a halo—upper third—was just visible and a fairly bright mock sun to west, both in a filmy, homogeneous, apparently very lofty cloud layer, partly obscured by cirro-cumulus. By 4.30 p.m. the mock sun had gone, but the halo segment had brightened and continued for at least an hour. From about 5.15 p.m. the tangent arc of the great halo—itself not seen—emerged over some 10° to 15,° and by 5.30 p.m. was quite bright, though disappearing soon after."

J. EDMUND CLARK.

Guildford (*Abbotswood*). "At Abbotswood, 1¼ miles outside Guildford, during the thunderstorm on the afternoon of July 22nd there fell 59·8 mm. (2·36 in.) of rain between 14h. 57m. and 15h. 55m. (Summer Time). During the 15 years that I have taken the rain (13 years in Herts, 2 years here) I have never known any fall to equal it. The rainfall for the 24 hours taken on the morning of the 23rd was 62 mm. (2·44 in.)."

ELLIOT KITCHENER.

So far as can be seen from the data available there were three areas of heavy precipitation: (A) the Hampstead-Southgate area, (B) the Central London area, (C) the Guildford area. Between (A) and (B) falls of 18 mm. (0·7 in.) to 20 mm. (0.8 in.) occurred, but between (B) and (C) there were areas in which little or no rain fell. Thus at Kew Observatory, which lies almost exactly on a line joining areas (B) and (C) the total fall between 7h. and 18h. amounted to only 3 mm. (0·12 in.). The Abbotswood record indicates that the rainfall in the Guildford area much exceeded that

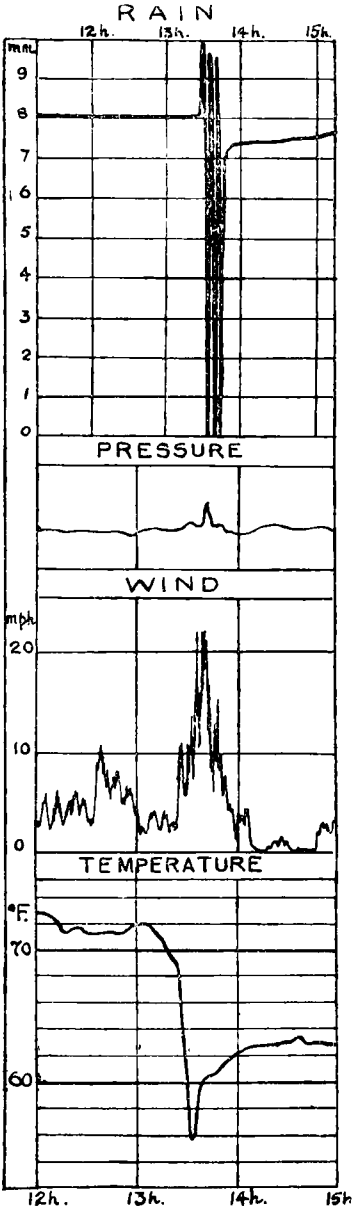


FIG. I. TRACES FROM AUTOGRAPHIC RECORDS,* SOUTH KENSINGTON, JULY 22ND, 1924.

* *N.B.*—The Pressure record is from a microbarograph.

in London. At South Farnborough, 7 miles from Guildford, 32 mm. (1·26 in.) was measured. The fall at Aldershot also seems to have been very heavy as it is stated that the lower parts of the Borough were flooded to a depth of 18 inches.

A tendency for the formation of a string of regions of heavy precipitation has been observed on some previous occasions, notably during the great rainstorm over the Quantock Hills on June 28th, 1917. Other examples can be found on reference to the volumes of *British Rainfall*. On the present occasion further records would probably result in an extension of the string south-westward, for press reports state that a "cloud-burst" occurred at Midhurst, Sussex, and a "deluge" over the western end of the Isle of Wight.*

Space permits only of a brief discussion of the origin of the storm. It was associated with the passage of a "dying" slow-moving depression over the south of England. This depression had followed an unusual track. On the morning of the 19th it was off the West Coast of Ireland, moving south-eastward. Having reached the Spanish Coast by 13h. on the 20th it turned northward and was over the English Channel on the 21st. Another centre developed over France, and the original disturbance remained nearly stationary. During the 22nd it moved slowly from southwest to northeast along a track agreeing closely with the string of areas of heavy precipitation. By 18h. it appeared as a mere bulge in the isobars over eastern England.

The wind currents were so feeble that the origin of the air supply cannot be definitely established. There was, however, a surface indraught of warm air from the Continent, resulting in temperatures of slightly over 70° F. in southeast England. An aeroplane observation over South Farnborough at 13h. 50m. disclosed a regular lapse from 63° F. at 1,890 feet to −15° F. at 20,000 feet. The dew point was 57° F., a value reached at about 3,000 feet. Above this point the lapse rate was much in excess of that for air saturated at 57° F., and in fact, approached the rate for dry air. Convectional clouds could therefore grow to great heights, and the cloud-top was in fact stated to be at 23,000 feet. The conditions were therefore extremely favourable for thunderstorms, given an initial impulse such as that provided by the warm surface current just mentioned.

* Later information shows that 3 inches of rain fell at Midhurst and 4 inches at Wisley (Surrey), and that 53 mm. (2·09 in.) were measured at Ormesby, near Gt. Yarmouth, thus extending the chain of heavy rain areas north-eastward to the Norfolk Coast.

The Question of the Permanence of Cyclone Tracks

By C. E. P. BROOKS, M.Sc.

MARSDEN MANSON, in a recent article in the *Monthly Weather Review**, shows that the present main storm track in North America coincides with the east-west watershed, and also approximately with the centres of glaciation during the Quaternary Ice Age and during the Huronian glaciation at the very beginning of the geological record. From this he infers that the track of depressions has remained practically unaltered throughout geological time, and that this is the cause of the development of the watershed referred to. The mechanism of the latter action is somewhat as follows: the earth's surface is in "isostatic equilibrium," which means that, in spite of the presence of mountain ranges and oceanic deeps, the load at a certain depth in the crust is everywhere the same. If a heavy mass is carried from one area to another, the former will rise and the latter sink, with corresponding sub-crustal movements, until equilibrium is re-established. Hence Manson supposes that the continual passage of depressions raises the earth's surface in the cyclone belt in two ways, firstly by the actual diminution of the air load, and secondly by the removal of detritus from the upper parts of the river valleys by the action of rain and snow. The first mode cited is hard to comprehend, but the second is well known to geologists, and its continuous action in the same area may result, in the absence of other disturbing factors, in the production of a low ridge cut into on either side by deep valleys.

The central part of North America consists of very old rocks, probably including remains of one of the primitive continents, and round this central core the present continent has been built up out of shore and river deposits accumulating for hundreds of millions of years. The core lay across the present main track of depressions and does seem to have been subject to intense denuding agencies, indicating heavy precipitation, throughout geological time, the losses being continually made good by isostatic elevation. This heavy precipitation may have been merely the effect of high land rising out of a warm sea, but it is equally possible that it indicates the presence of a favourite track of depressions in about 50° N throughout the history of the continent, as Marsden Manson supposes.

The principle must not be applied too rigidly, however. The North American ice-sheets certainly originated along the main

*MANSON, MARSDEN. The Physical and Geological traces of the Cyclone belt across North America. *Washington M.W. Rev., Vol.* 52, 1924, *p.* 102.

present track of depressions, so that at the beginning of the Quaternary Ice Age the belt of greatest storminess was probably near its present position, but there is considerable evidence that as the ice-sheets developed the tracks suffered a progressive shifting to the south. This seems to have been one of the reasons why the ice-sheets attained such enormous dimensions, while different centres reached their maxima at different times. The process is clearer in Europe than in America: in north-west Europe glaciation began in Scandinavia, and the area of maximum snowfall progressed south-westwards, first to Scotland and then to Ireland. The reverse process of the restoration of the present system of tracks in Europe at the close of the Ice Age can be followed very clearly†. Even as late as the Continental phase (*Ancylus* stage) of 7,000-6,000 B.C., there was still a permanent anticyclone over Scandinavia, and the shape of the sand dunes formed during this dry period indicates persistent north-westerly winds over the whole Baltic region, the normal pressure distribution resembling that now occurring during the May frosts‡. During the Ice Age the Mediterranean lands were richly watered, indicating a greatly increased frequency of depressions passing along the Mediterranean. In America the flooding of the Great Basin indicates a similar increased frequency of depressions following the southern or Arizona track during the Ice Age.

Fossil plants show that during the Tertiary period a mild equable rainy climate existed in high latitudes in at least three areas—western Greenland, western Siberia and Alaska—all of which lay then on the western shores of continental areas. This indicates that the prevailing winds in these regions were westerly or south-westerly, so that the low-pressure areas lay still further north. At this time the Arctic regions were occupied by an extensive and comparatively warm ocean, fed by three currents analogous to the Gulf Stream, and there was little or no floating ice. Under these circumstances storms would be few and of small intensity, and their tracks must have lain much further north than at present. There may have been another storm belt further south, but, so far as I know, the only evidence which can be adduced for it is a local glaciation of the San Juan Mountains of Colorado at the beginning of the Eocene period, some time before the period of optimum temperatures.

Much earlier, in Upper Permian times, there was a widespread development of arid climates, especially in parts of North

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†BROOKS, C. E. P. The Evolution of Climate in North-West Europe. *London, Q.J.R. Met. Soc., Vol.* 47, 1921, *p.* 173.

‡HOGBOM I. Ancient inland dunes of northern and middle Europe. *Stockholm, Geog. Ann. Vol.* 5, 1923, *p.* 113.

America and Europe which at present have a considerable rainfall, derived from passing depressions.

Manson's hypothesis of the permanence of storm tracks is based mainly on one great generalisation, supported by a few isolated facts. I have quoted other facts which point to a different conclusion, but I am not prepared to reject the hypothesis entirely without a much fuller study of the climatic conditions of the different epochs. I think the most that can be claimed is that the storm tracks have swung north and south with the varying physical geography of the earth, and that at present the tracks occupy more or less their average position.

OFFICIAL NOTICE

In consequence of the retirement from the Service of the Meteorological Office of Dr. A. Crichton Mitchell, the following changes are announced to take place on October 1st, 1924. Major A. H. R. Goldie, Superintendent of the Local Centres Division, will succeed Dr. Crichton Mitchell as Superintendent of the Meteorological Office at Edinburgh. Captain F. Entwistle, Superintendent of the Instruments Division, will become Superintendent of the Local Centres Division, and Mr. E. G. Bilham, Assistant Superintendent in the Forecast Division, will be promoted Superintendent of the Instruments Division.

OFFICIAL PUBLICATIONS

The following publications have recently been issued :—

PROFESSIONAL NOTES—

No. 34. *How to observe the Wind by Spheres shot upwards.* By L. F. Richardson, B.A., F.Inst.P. (M.O. 245n.)

The general method consists in shooting upwards small steel spheres in such a way that the pressure of the wind upon a sphere in its trajectory brings it back to the starting point when it returns to earth. The small angle by which the gun has to be deflected from the vertical to get this result gives a measure of the wind aloft, and, by determining this angle for gradually increasing times of flight, values of wind velocity and direction in successive layers of the atmosphere are found. The method is likely to prove especially valuable when the weather is foggy and pilot balloons therefore cannot be observed.

RÉSEAU MONDIAL 1915. Part V. of the British Meteorological and Magnetic Year Book 1915. (M.O. 222g.)

Royal Meteorological Society

A SUMMER meeting of the Society was held by invitation of the Director, Sir John Russell, F.R.S., at the Rothamsted Experimental Station, Harpenden, on Friday, July 18th. In the morning the party visited the classical field plots, the meteorological station and the drainage gauges, and interesting particulars relating to each were given by the Station staff. In the afternoon papers were read and discussed, and after tea the laboratories were inspected. A vote of thanks to the Rothamsted authorities, proposed by Mr. C. J. P. Cave, President of the Society, was responded to by Dr. B. Keen, Assistant Director of the Station, who presided in the unavoidable absence of the Director.

The following papers were read:—

R. A. Fisher, M.A.—Adaptation of Variety to Climate.

One of the main problems attacked by the statistical laboratory at Rothamsted in recent years has been to ascertain numerically the effect of weather on the yield of farm crops. The Rothamsted data give the yield of wheat on thirteen plots which have been under uniform manurial treatment since 1851, and rain records from a large gauge set up in 1853. From these series of values it has been possible to evaluate the actual gain or loss of each crop consequent upon an additional inch of rain at any time during the harvest year. A comparison of the different response of the different plots to rainfall shows the possibility of the farmer adapting his manurial treatment to season and to climate, especially in relation to nitrogenous fertilisers. The work has involved a detailed analysis of the distribution of rainfall through the year for each year since 1853, some of the results of which are of interest. The annual rainfall fluctuations are not at haphazard, but at two periods, centred about 1879 and 1914, there were prolonged spells of significantly increased rainfall. There is also evidence to show that Decembers are becoming increasingly wet.

In the discussion reference was made to the relation between autumnal rainfall and subsequent yield of wheat, formulated by Sir Napier Shaw for eastern England,* and to the fact that this relation did not hold for the Rothamsted plots. This might be because, at Rothamsted, wheat was grown on the plots every year without intermission, whereas the actual yield of wheat in eastern England must depend partly on the area sown, which, in turn, depends partly on the autumn rainfall, because in a wet season it is impossible to prepare the ground for the crop.

W. B. Haines, B.Sc.—A comparison of the readings taken at Rothamsted with three types of radiation recorders.

This paper deals with a comparison of the readings taken at

* *Proc. Roy. Soc., Vol.* 78 (*series A*), 1906, *p.* 69.

Rothamsted with three types of radiation recorder, viz., the Callendar instrument, taken as standard, the Wilson radio-integrator, and the Campbell-Stokes sunshine recorder. Reference is also made to a fourth set of data, that given by an evaporimeter of the porous candle type. A diagram made by plotting the data to suitably adjusted units brings out the following points: (1) The Wilson integrator gives readings much too low during the winter months; (2) The hours of bright sunshine should be corrected by a factor depending upon the time of day and year (*i.e.*, upon the sun's altitude). A formula deduced by Ångström from the Stockholm data, for calculating total radiation from hours of bright sunshine, is examined and found fairly satisfactory for the Rothamsted data. The evaporimeter results follow the hours of sunshine very closely, but some care is needed in the choice of a site for this instrument.

Correspondence

To the Editor, *The Meteorological Magazine*

The Boundary Between Calms and Neighbouring Breezes

THE following observation may be of interest. On the evening of May 4th (18h. local time) it was observed that, as frequently occurs, a large portion of the sea was dead calm while the rest was covered with ripples. Sailing boats on one side of the boundary between the two areas had a southerly breeze off the land, of about force 2; while on the other side they had no breeze at all. At the same time a steamer was leaving Malta, and was emitting heavy smoke. For about two miles to leeward the smoke drifted along the sea surface with very little dissipation, but on reaching the boundary between the calm and rippled areas, it rose at an angle of between 30° and 40° to a height of about 200 feet. Thereafter it continued to move in the same direction until it was lost in the distance, remaining at a constant height of about 200 feet, but becoming much more diffuse.

This is presumably a case of warm air rising over an inert mass of cool air, and, under the right conditions, it could evidently give rise to low cloud formation, or to fog bank.

It would be interesting to learn whether any direct observations have been made at the boundaries of local gusts. It seems possible that the patches of disturbed water in gusty winds may be caused by the converse process: a sort of progressive cascade of rapidly moving air. The remark has often been made that

some winds " bear more heavily " on the water than others, and, for the same velocity, raise a much higher sea. No doubt some types of turbulence consist chiefly of localised descending currents and diffuse ascending currents, while others consist of localised ascending currents and diffuse descending currents. One might expect, for example, a wind in which cold upper air is overtaking surface air in contact with a warm sea to show localised descending currents. If such descending currents are more characteristic of winter than of summer, the relative " heaviness " of winter gusts, as noticed by sailing boats in the Mediterranean, would be accounted for, since a descending current would become more nearly normal to the sail surface as the boat heeled to the gust. In summer, the majority of local gusts may, like those of dust devils, consist of ascending air.

W. A. HARWOOD.

Meteorological Office, Pieta, Malta, July 23rd, 1924.

Halo at Waringstown

I HAVE read with much interest, Mr. G. A. Clarke's account of an elliptic halo in the July issue of the *Meteorological Magazine,* and would like to place before your readers an observation of my own. At 11h. G.M.T. on April 27th, 1923, the southern sky was covered with cirrus haze, wind south-east. At 11h. 15m. a brilliant halo of about 20° was in evidence around the sun and perfect in structure throughout but absolutely without any prismatic tints. At 11h. 30m. an upper arc of contact but bent downwards appeared conjointly at the " 12 o'clock " point of the halo of 20°. Shortly afterwards a lower arc appeared at the " six o'clock " point, arms bent upwards, and meeting the arms of the upper arc, joined together forming a large " bulge " outside the principal halo. The ellipse was highly coloured with orange, fading to bluish green. The phenomenon remained visible for about an hour and 10 minutes. Hail showers fell in the evening giving a total when thawed of 0·11 inches.

W. J. GIBSON.

The Forge, Waringstown, Co. Down, July 19th, 1924.

The Reform of the Calendar

SEEING that you have introduced into your July number the question of a Reformed Calendar, will you allow a mere amateur to support your objection to a 13 months' scheme, which would give us neither half years nor quarters ; and to object further to the " odd day," a " Dies non " I presume, which that scheme would entail. What could an unfortunate observer do with it either for his totals or his averages ?

The perfect calendar will not be possible to man till he can control the orbit of the earth itself. As yet we must submit to a course of nature in which nothing does fit exactly. Astronomical periods are incommensurate one with another. Days do not fit with the lunar months : and neither days nor solar months fit with solar years. The history of the Calendar is that of a slow struggle, for thousands of years, to discover and adjust the small misfittings.

We owe much to the reformation of the Calendar carried through under Julius Cæsar, with months alternately of 31 and of 30 days, although his consistent plan was badly marred by the vanity of Augustus, who, that he might have 31 days for the month to which he gave his name, interchanged the thirty-firsts and the thirtieths in all the months from August to December.

Seeing, however, that in ordinary years of 365 days there are but 5 spare days over and above 12 × 30, it would have been better if the first month had had 30 days, the second 31, and so on alternately, the twelfth month getting 31 days in Leap Year only. No nearer approach to uniformity is possible if the 12 months are to embrace the whole year.

If, again, the months were themselves shifted by 10 days, so that each quarter of the year might begin as nearly as possible coincidently with the four Solar Epochs, *i.e.*, the Summer and Winter Solstices and the Vernal and Autumnal Equinoxes, then there would be a Calendar resting on a sound Astronomical basis, suitable for every nation and every climate.

It might probably be found best to begin the year either at the Vernal Equinox with a thirty day April, or at the Autumnal Equinox with a thirty day October. In any case the extra day of Leap Year should be the last day of the year.

H. A. BOYS, F.R.Met. Soc.

Spring Hill, St. Mary Bourne, July 23rd, 1924.

NOTES AND QUERIES

The School of Meteorology

THE retirement of Sir Napier Shaw from the Professorship of Meteorology at the Imperial College of Science and Technology is announced to take place on August 31st, 1924. An account of his life and work up to 1920 will be found in the *Meteorological Magazine* for September, 1920. Since then he has devoted himself to the development of the teaching of meteorology in this country both as a pre-graduate and post-graduate course with a view to making the School of Meteorology a centre of research for students of all nationalities. The School has also undertaken the training of R.A.F. Officers for meteorological work in the Middle East. During the four years he has found

time in the midst of his duties as Professor and as President of the International Meteorological Committee to publish *The Air and its Ways*, one of the most valuable contributions to meteorology in recent years, a new and enlarged edition of *Forecasting Weather* and numerous other papers. After he leaves the School, Sir Napier hopes to continue his work on the *Manual of Meteorology*, of which Part IV. was published in 1919.

Sir Gilbert Walker, whose retirement from the Office of Director-General of Indian Observatories was noted in the July issue of this Magazine, has been appointed as his successor.

Radiation from the Sky

RADIATION MEASURED AT BENSON, OXON, 1924.

Unit: one gramme calorie per square centimetre per day.

ATMOSPHERIC RADIATION only (dark heat rays).

Averages for Readings about time of Sunset.

		April.	May.	June.
Cloudless days:—				
Number of readings	n	7	No observations	12
Radiation from sky in zenith ...	π I	545		576
Total radiation from sky ...	J	579		616
Total radiation from horizontal black surface on earth ...	X	731		764
Net radiation from earth ...	X—J	152		148

DIFFUSE SOLAR RADIATION (luminous rays).

Averages for Readings between 9 h. and 15 h. G.M.T.

Cloudless days:—				
Number of readings	n_0	2	No observations	2
Radiation from sky in zenith ...	πI_0	30		40
Total radiation from sky ...	J_0	30		39
Cloudy days:—				
Number of readings	n_1	2		3
Radiation from sky in zenith ...	πI_1	63		115
Total radiation from sky ...	J_1	58		104

Unit for I = gramme calorie per day per steradian per square centimetre.

Unit for J and X = gramme calorie per day per square centimetre.

For description of instrument and methods of observation, see *The Meteorological Magazine*, October, 1920, and May, 1921.

The Norwegian Meteorological Service

THE tragic story of the ships carrying on the Norwegian Meteorological Service in the Arctic was related by Dr. Simpson in the *Meteorological Magazine* last December. It will be remembered that one of the ships, the "Annie," left Mygbugten last July, and that when search was being made for her towards the end of the year the relief ship foundered in a storm. Shackleton's old ship, the "Quest," has now taken up the dangerous task and left Patricksfjord, Iceland, on July 8th for Angmagsalik, Greenland. At Angmagsalik the "Quest" will find the crew of the Danish ship "Teddy," which has been fast in the ice off the Greenland coast for thirteen months and which was found by a Norwegian whaler a little time ago. It is hoped that the "Annie" may likewise be found in the ice. It is true that, being equipped with wireless, she should have been able to communicate with the world but there is a possibility that the wireless apparatus may have broken down though the ship is safe.

Typhoon at Hong Kong

The Marine Observer for August, 1924, contains details of the history of the "Hong Kong Typhoon, August 18th, 1923." There were three ships in the track of the centre of this typhoon so that the variations of the diameter of the calm area, the "eye of the storm," could be followed. On the 16th this diameter was about 28 miles. On the 18th when the storm was approaching Hong Kong it had diminished to 7 miles. The transition from the region of hurricane winds into the calm was then quite sudden.

The centre of the storm passed 14 miles to the south of Hong Kong observatory. The autographic records, which are reproduced in the *Marine Observer*, show remarkable symmetry. The highest gust is shown by the record from the Dines anemograph as 130 miles per hour. This is, we believe, the greatest wind speed ever recorded autographically, and it is to be hoped that the instrument will be tested so that the estimate can be verified. The recorder is not usually calibrated up to 130 miles per hour. Between 4h. and 10h. 20m. on August 18th the average wind speed at the observatory increased from 12 miles an hour to 83 miles an hour whilst the distance of the centre of the typhoon decreased from 93 miles to 14 miles. It is of great interest to notice that the product of speed and distance remained practically constant during this time.

The general uniformity of temperature at Hong Kong during the episode is perhaps more remarkable than a curious temporary drop of 2° F. which occurred shortly after the passage of the worst of the gale.

Gale Warnings Issued by the Meteorological Office

A STORM which developed rapidly on Thursday, July 17th, affords a good example of the help which the gale warning service of the Meteorological Office can give to those responsible for the navigation of small craft in British Coastal Waters and in the North Sea. A long spell of fair, quiet weather had prevailed up to the 17th of the month, but in the early hours of that day a " secondary " depression was shown by the weather reports from Ireland to be approaching from the Atlantic. During the morning it became evident that the secondary depression was increasing in intensity, and, after the 2 p.m. readings were received at the Meteorological Office, gale warnings were issued to the gale warning stations along the shores of the eastern part of the English Channel and the southern North Sea, and the following message was sent out from the Radio stations at Lands End and Niton: " Gale warning SW to W, force 7 to 8 expected southern coasts Start Point to Harwich." Gale warnings are issued on 600 metre wavelength preceded by the International Safety Signal T.T.T. immediately upon receipt at Radio stations.

The wind at the time at which the warning was issued on the 17th was of moderate force in the Straits of Dover and light over the southern North Sea. This condition persisted for 4 or 5 hours afterwards in the Straits and rather longer in the southern North Sea. Then the wind rose rapidly during the evening, and high winds or gales were experienced at night over the area, at first from south or south-west changing suddenly to north-west.

Many lives were lost on the Dutch and Belgian coasts, of fishermen who presumably had gone out of sight of coast warnings without any means of receiving wireless messages, and were in consequence caught unprepared.

Atlas Pluviometrico do Nordéste do Brasil

The rainfall Atlas recently published for the extreme north-eastern part of Brazil by the Inspectoria Federal de Obras contra as Seccas contains a series of five maps giving the annual fall, the driest and wettest years, and the months of greatest and least fall for the period 1912-1920. It is interesting to note that the maps for 1914-15 and 1916-17, the driest and wettest years respectively, are complementary, the extreme values being in the north in each case,while the south showed the least deviation.

Artificial Lightning

THE results of some interesting experiments on high voltage phenomena carried out by Mr. F. W. Peek of the General Electric Company, are discussed in a paper* published recently in the

* *Philadelphia Pa. J. Frank, Inst:* Vol. 197, Jan. 1924, p. 1.

Journal of the Franklin Institute. The experiments were undertaken primarily with a view to improving the design of the insulators used on power transmission lines. Gaps between needle points were so arranged that voltages up to nearly 2,000,000 volts had to be applied, if the voltage were applied impulsively, before the " spark-over " occurred. It was found that, whereas in the case of needle point gaps the voltage when applied impulsively was approximately twice as great as the continuously applied voltage necessary to produce sparking, with spheres there was little difference in " spark-over " voltage whether applied impulsively or continuously. The experiments proved that the ratio of the length of the gap to the " spark-over " voltage for high voltages is the same as that found for comparatively low voltages.

We, as meteorologists, are concerned more particularly with the application of these experiments to the problem of lightning discharges. Mr. Peek reproduced in miniature the electrical conditions believed to exist during a thunderstorm. He introduced near the ground insulated wires corresponding with power transmission wires in the open, and found that with a model representing a charged cloud at 860 feet the voltage statically induced on the insulated wire at the moment the cloud discharged was approximately 2 per cent. of the voltage producing the lightning flash. He estimates that in nature the voltage induced in a power transmission line by a cloud at 1,000 ft. discharging to earth would be of the order of 1 per cent. of the cloud-earth voltage. Induced voltages on transmission lines of the order of 1,000,000 volts have been measured during thunderstorms. It is deduced therefore that the voltage causing a severe lightning flash to earth may be about 100,000,000 volts.

Review

An Introduction to Forecasting Weather. By RAYMOND ZEALLEY, F.R. Met. Soc. $7\frac{1}{2} \times 5\frac{1}{2}$, pp. 32. *Illus.* Cambridge : Heffer, 1922. Price 1/- net.

This attractive little book represents the jottings in the note-book of the practical man who is becoming acquainted with the technical terms used in the forecaster's office. You can see at a glance which way a cyclone spins in either hemisphere, what is the difference between " backing " and " veering " winds or how a nascent secondary shows itself on the map. We can hardly agree with the author in giving the title " Typical Example of Strato-Cumulus " to the frontispiece.

Obituary

Frank Hagar Bigelow.—Professor Bigelow, whose death at Vienna was announced in the May number of the *Meteorological Magazine,* was born at Concord, Mass., U.S.A., in 1851. After graduating at Harvard he spent some years at the Cordoba Observatory in Argentina as an astronomer, held a professorship of mathematics in Racine College, and subsequently was assistant in the Nautical Almanac Office at Washington. In 1891 he became Minister of St. John's, Washington, and was also appointed professor of meteorology in the U.S. Weather Bureau, both of which charges he maintained until 1910 when he again returned to Argentina, being at first engaged in special researches on evaporation at Cordoba, and latterly (from 1916 to 1921) as Director of the neighbouring magnetic observatory at Pilar.

Bigelow's books and memoirs covered a wide field. Among the most important may be mentioned a large work on the barometric pressure of the United States, an elaborate monograph on *Eclipse Meteorology and Allied Problems,* and several important papers dealing with the relations of solar conditions to terrestrial weather and magnetism. He is known to meteorologists for his great report on the cloud observations made all over the globe in the years 1896 and 1897. From 1910 onwards he was specially engaged in devising a simple adjustment of the thermodynamic adiabatic equations to an exact and practical form of computation which would adapt them to the non-adiabatic system prevailing in the solar and terrestrial atmosphere. Towards this provision of a " reformed meteorology " Professor Bigelow wrote two books, *Atmospheric Circulation and Reduction* 1915, and a *Treatise on the Sun's Radiation* 1918, addenda in the form of five supplements appearing at intervals between 1919 and 1923. Failing eyesight induced him to resign his Argentine post in 1921 but he continued his labours in Vienna, where he made his home. It is not easy to form an exact estimate of the value of Professor Bigelow's later work, but there is no doubt that he spared neither time, money, nor health in a sustained endeavour to place his " case " before his meteorological colleagues. It is to be hoped that some competent person will have the patience to examine the material and let the world know whether there is " anything in it."

News in Brief

Mr. E. A. Milne, assistant director of the Solar Physics Observatory at Cambridge, has been appointed to the Beyer Chair of Applied Mathematics at Manchester.

The Weather of July, 1924

THE most striking features of the weather of the month were the severe local thunderstorms and general heavy rains. During the first week low pressure prevailed to the west and north of the British Isles, and secondary depressions passing across the country in a north-easterly direction caused generally cool and unsettled weather, with rainfall above the weekly average except in the south-eastern districts of England. Thunderstorms were widespread in England and Ireland on the 3rd and 4th and gales occurred at exposed places in the south on the 3rd. On the 9th the high pressure area to the south spread northwards over Great Britain and the North Sea and a spell of fine warm weather set in over the country generally, though owing to the low pressure area which still prevailed to the north-west conditions on the west coasts of Ireland and Scotland remained unsettled. Temperature rose gradually until the 12th, which was the hottest day of the year in most districts, the highest temperatures recorded for England, Scotland and Ireland on that day being 90° F. at Camden Square, London, 81° F. at Fort Augustus and 74° F. at Dublin. The spell of fine weather, however, broke on the 17th, an intense secondary depression passing eastwards across southern England, causing heavy rain and local gales in the south. From then until the end of the month the weather was cool and unsettled and depressions passing across the southern districts caused heavy local rains and numerous thunderstorms. Two severe thunderstorms occurred in London, one on the 22nd, a description of which will be found on p. 152, and one on the 29th. During the latter storm the rainfall varied considerably, *e.g.*, only 3 mm. were measured at South Kensington, while Hampstead had 54 mm. Many of the thunderstorms in the other parts of the country were also accompanied by heavy rain. The heaviest rainfall in a single day of the month, 103 mm. (4·1 in.), occurred at Wisley (Surrey) on the 22nd. Other notable falls were 74 mm. (2·9 ins.) at Falmouth in the 24 hours ending midnight on the 21st, which is the largest amount ever recorded there for a similar period, 64 mm. (2·5 ins.) at Brushford, Somerset, on the 20th, and 64 mm. (2·5 ins.) at Douglas (Isle of Man) on the 28th. At Hampstead the July rainfall total 193 mm. (7·6 ins.) was the largest recorded in any month since observations began there in 1858. The nearest approach was 180 mm. (7·1 ins.) in October, 1865.

Western Europe had mainly fine weather during the first half of the month, with some very hot days, especially in Paris on the 14th. Castile and Andalusia were suffering from prolonged drought, no rain having fallen for nearly four months. Drought also prevailed in southern Russia, but north and north-west Russia was suffering from prolonged cold and rainy weather,

and on the 1st severe storms caused floods in the northern Tyrol. The second half of the month was exceptionally stormy over the whole of Europe. On the 18th a heavy gale off the Belgian and Dutch coasts caused considerable loss of life. There were numerous thunderstorms in Switzerland, culminating on the 23rd. This was followed on the 27th by a sharp fall of temperature in Switzerland and northern Italy, snow falling as low as 4,000 feet. On the 22nd heavy rains were reported from Tolosa (northern Spain), and on the 30th another severe thunderstorm visited Brussels and Ghent, where considerable damage was done by lightning.

In India the monsoon rains were generally good, and in the south were very heavy, especially in Cochin and Travancore. The river Cauvery rose to 34½ feet above its usual level at Erode, and thousands of houses have been swept away, with much loss of life. The Coleroon river (south of Pondicheri) is also in flood. Owing to the breaking down of bridges railway communication has ceased. On the 25th it was reported that Bombay Presidency was threatened with drought, but very heavy rain fell at Ahmedabad on the 29th. In China the floods are even more serious, and the previous high water mark of 1917 has been exceeded. In the province of Chih-li the flooded area exceeds 10,000 square miles, and at least a million people are homeless. The port of Tientsin is in great danger. Great floods are also reported from Ho-nan (central China) where about a million people are homeless. By the 21st the July rainfall in North China had exceeded 20 inches, and rain was still falling in heavy showers. The normal for the month is about 7 inches.

In North America, after the hurricane at the end of June, conditions have been rather quiet. In Canada hot dry weather during the first half of the month threatened drought in the agricultural districts round Winnipeg, but on the 16th a depression following a rather northerly track brought good rains.

The special message from Brazil states that the rainfall over the whole country was small, being 21 mm., 10 mm. and 35 mm. below the normal in the northern, central and southern districts respectively. Well developed anticyclones continued to cross the country, but were often interrupted by areas of low pressure. The weather was generally favourable for wheat but not so good for the other crops. Pressure at Rio de Janeiro was 1·7 mb. above normal and temperature 2° F. above normal.

Rainfall July, 1924: General Distribution

England and Wales	152	per cent. of the average 1881-1915.
Scotland	152	
Ireland	132	
British Isles	149	

Rainfall: July, 1924: England and Wales.

CO.	STATION.	In.	mm.	Per-cent. of Av	CO.	STATION.	In.	mm	Per-cent. of Av.
Lond.	Camden Square.....	5·69	145	239	*War.*	Birminghm, Edgbaston	3·28	83	141
Sur .	Reigate, Hartswood...	4·18	106	199	*Leics*	Leicester Town Hall...	2·47	63	...
Kent.	Tenterden, View Tower	3·26	83	156	,, .	Belvoir Castle.....	2·35	60	97
,,	Folkestone, Boro. San.	3·51	89	...	*Rut .*	Ridlington.....	3·10	79	...
,,	Broadstairs	...	...	...	*Linc.*	Boston, Skirbeck	1·97	50	90
,, .	Sevenoaks, Speldhurst.	4·10	104	...	,, .	Lincoln, Sessions House	1·71	43	77
Sus .	Patching Farm.....	3·67	93	153	,, .	Skegness, Estate Office.	...	...	...
,, .	Eastbourne, Wilm. Sq.	2·61	66	119	,, .	Louth, Westgate	2·42	61	97
,, .	Tottingworth Park....	4·60	117	184	,, .	Brigg	2·13	54	91
Hants	Totland Bay, Aston...	3·15	80	164	*Notts.*	Worksop, Hodsock....	2·01	51	89
,, .	Fordingbridge, Oaklnds	4·26	108	213	*Derby*	Mickleover, Clyde Ho..	3·09	79	126
,, .	Portsmouth, Vic. Park.	2 62	67	128	,, .	Buxton, Devon. Hos...	5·37	136	137
,, .	Ovington Rectory	4·81	122	186	*Ches.*	Runcorn, Weston Pt...	4·44	113	161
,, .	Grayshott	4·35	110	178	,, ..	Nantwich, Dorfold Hall	4·27	109	...
Berks	Wellington College...	3·87	98	187	*Lancs*	Bolton, Queen's Park .	4·68	119	...
,, .	Newbury, Greenham..	...	...	...	,, ..	Stonyhurst College....	5·26	133	136
Herts.	Bennington House....	4·42	112	181	,, ..	Southport, Hesketh...	4·28	109	150
Bucks	High Wycombe	5·41	137	275	,, ..	Lancaster, Strathspey.	3·39	86	...
Oxf..	Oxford, Mag. College..	3·47	88	153	*Yorks*	Sedbergh, Akay	5·39	137	120
Nor .	Pitsford, Sedgebrook..	2·92	74	124	,, .	Wath-upon-Dearne ...	2·29	58	91
,, .	Eye, Northolm.....	3·17	81	...	,, .	Bradford, Lister Pk...	3·40	86	124
Beds.	Woburn, Crawley Mill.	3·06	78	130	,, .	Oughtershaw Hall	6·96	177	...
Cam.	Cambridge, Bot. Gdns.	...	...	...	,, .	Wetherby, Ribston H..	3·66	93	146
Essex	Chelmsford, CountyLab	3·43	87	...	,, .	Hull, Pearson Park ...	2·99	76	120
,, .	Lexden, Hill House...	3·21	81	...	,, .	Holme-on-Spalding ...	2·90	74	...
Suff .	Hawkedon Rectory ...	3·41	87	140	,, .	Lowthorpe, The Elms.	4·05	103	177
,, .	Haughley House.....	2·68	68	...	,, .	West Witton, Ivy Ho..	...	...	...
Norf.	Beccles, Geldeston....	2·29	58	98	,, .	Pickering, Hungate ...	3·58	91	...
,, .	Norwich, Eaton	...	...	...	,, .	Middlesbrough	3·61	92	141
,, .	Blakeney	1·75	44	77	,, .	Baldersdale, Hury Res.	4·53	115	146
,, .	Swaffham	1·90	48	74	*Durh*	Ushaw College	4·16	106	149
Wilts.	Devizes, Highclere....	3·85	98	166	*Nor .*	Newcastle, Town Moor.	4·26	108	161
Dor .	Evershot, Melbury Ho.	4·64	118	183	,, .	Bellingham Manor....	4·66	118	...
,, .	Weymouth, Westham..	3·49	89	194	,, .	Lilburn Tower Gdns...	5·25	133	...
,, .	Shaftesbury, Abbey Ho.	3·71	94	144	*Cumb*	Penrith, Newton Rigg..	...	...	...
Devon	Plymouth, The Hoe...	5·01	127	180	,, .	Carlisle, Scaleby Hall .	3·90	99	119
,, .	Polapit Tamar	4·13	105	153	,, .	Seathwaite	11·45	291	135
,, .	Ashburton, Druid Ho..	5·97	152	196	*Glam.*	Cardiff, Ely P. Stn....	5·91	150	190
,, .	Cullompton	4·30	121	160	,, .	Treherbert, Tynywaun	8·97	228	...
,, .	Sidmouth, Sidmount ..	3·89	110	155	*Carm*	Carmarthen Friary....	5·43	138	155
,, .	Filleigh, Castle Hill ...	4·99	127	...	,, .	Llanwrda, Dolaucothy	6·76	172	156
,, .	Hartland Abbey... ..	4·55	116	...	*Pemb*	Haverfordwest, Portf'd	...	...	...
Corn.	Redruth, Trewirgie ...	4·02	102	132	*Card.*	Gogerddan.....	5·78	147	150
,, .	Penzance, Morrab Gdn.	3·77	96	139	,, .	Cardigan, County Sch. .	5·69	145	...
,,	St. Austell, Trevarna..	6·25	159	187	*Brec .*	Crickhowell, Talymaes	6·00	152	...
Soms	Chewton Mendip	4·83	123	138	*Rad .*	Birm. W. W. Tyrmynydd	6·45	164	157
,, .	Street, Hind Hayes ...	3·19	81	...	*Mont.*	Lake Vyrnwy	7·51	191	219
Glos..	Clifton College	5·31	135	188	*Denb.*	Llangynhafal	3·94	100	...
,, .	Cirencester	4·65	118	175	*Mer .*	Dolgelly, Bryntirion..	6·99	177	164
Here.	Ross, County Obsy. ...	4·10	104	182	*Carn.*	Llandudno	3·66	93	153
,, .	Ledbury, Underdown.	4·22	107	187	,, .	Snowdon, L. Llydaw 9	13·20	335	...
Salop	Church Stretton.....	5·36	136	219	*Ang .*	Holyhead, Salt Island.	3·64	92	139
,, .	Shifnal, Hatton Grange	4·67	119	208	,, .	Lligwy	...	...	...
Staff.	Tean, The Heath Ho...	4·59	117	158	*Isle of Man*				
Worc.	Ombersley, Holt Lock.	3·43	87	160		Douglas, Boro' Cem...	5·76	146	188
,, .	Blockley, Upton Wold.	3·90	99	160	*Guernsey*				
War.	Farnborough.....	3·36	85	131		St. Peter Port Grange.	2·77	70	137

Rainfall: July, 1924: Scotland and Ireland

CO.	STATION	In.	mm.	Per-cent. of Av.	CO.	STATION.	In.	mm	Per-cent of Av.
Wigt.	Stoneykirk, Ardwell Ho	4·31	109	149	*Suth.*	Loch More, Achfary...	6·20	157	116
,, .	Pt. William, Monreith.	4·21	107	...	*Caith*	Wick	3·86	98	147
Kirk.	Carsphairn, Shiel.	6·52	166	...	*Ork .*	Pomona, Deerness	2·56	65	100
,, .	Dumfries, Cargen.....	4·93	125	152	*Shet .*	Lerwick	4·00	101	175
Dum	Drumlanrig	5·40	137	158					
Roxb	Branxholme	4·78	121	158	*Cork.*	Caheragh Rectory	6·92	176	...
Selk .	Ettrick Manse.....	6·50	165	...	,, . .	Dunmanway Rectory.	6·94	176	178
Berk.	Marchmont House	5·76	146	189	,, . .	Ballinacurra	4·09	104	147
Hadd	North Berwick Res....	4·00	102	155	,, . .	Glanmire, Lota Lo. ...	4·31	109	149
Midl	Edinburgh, Roy. Obs..	4·22	107	162	*Kerry*	Valencia Obsy.	5·53	140	146
Lan .	Biggar	4·48	114	154	,, .	Gearahameen	5·20	132	...
Ayr .	Kilmarnock, Agric. C..	3·56	90	114	,, .	Killarney Asylum.....	3·65	93	110
,, .	Girvan, Pinmore.....	3·51	89	96	,, .	Darrynane Abbey	4·12	105	108
Renf.	Glasgow, Queen's Pk..	...	...	...	*Wat .*	Waterford, Brook Lo..	...	...	...
,, .	Greenock, Prospect H..	4·16	106	106	*Tip .*	Nenagh, Cas. Lough...	3·49	89	111
Bute.	Rothesay, Ardencraig.	5·96	151	150	,, .	Tipperary	2·81	71	...
,, .	Dougarie Lodge	4·89	124	...	,, .	Cashel, Ballinamona ..	3·27	83	113
Arg .	Glen Etive.....	...	...	...	*Lim .*	Foynes, Coolnanes	2·66	67	86
,, .	Oban	6·20	157	...	,, .	Castleconnell Rec.	3·19	81	...
,, .	Poltalloch	6·92	176	169	*Clare*	Inagh, Mount Callan ..	6·69	170	...
,, .	Inveraray Castle.....	7·23	184	145	,, .	Broadford, Hurdlest'n	4·76	121	...
,, .	Islay, Eallabus.....	5·68	144	167	*Wexf*	Newtownbarry	3·66	93	...
,, .	Mull, Benmore	18·20	462	...	,, .	Gorey, Courtown Ho...	4·59	117	156
Kinr.	Loch Leven Sluice	5·73	145	199	*Kilk.*	Kilkenny Castle	3·30	84	117
Perth	Loch Dhu	8·00	203	166	*Wic .*	Rathnew, Clonmannon	4·01	102	...
,, . .	Balquhidder, Stronvar.	7·07	180	164	*Carl .*	Hacketstown Rectory .	4·02	102	117
,, . .	Crieff, Strathearn Hyd.	4·67	119	157	*QCo..*	Blandsfort House.....	3·57	91	114
,, . .	Blair Castle Gardens ..	4·73	120	...	,,	Mountmellick	3·97	101	...
,, .	Coupar Angus School..	4·53	115	192	*KCo.*	Birr Castle.....	2·95	75	100
Forf.	Dundee, E. Necropolis.	4·74	120	173	*Dubl.*	Dublin, FitzWm. Sq...	3·59	91	140
,, .	Pearsie House.....	5·82	148	...	,, .	Balbriggan, Ardgillan .	3·56	90	131
,, .	Montrose, Sunnyside..	4·53	115	221	*Me'th*	Drogheda, Mornington	3·57	91	...
Aber.	Braemar Bank	4·30	109	168	*W.M*	Mullingar, Belvedere .	5·18	132	163
,, .	Logie Coldstone Sch. ..	5·52	140	186	*Long*	Castle Forbes Gdns....	4·14	105	133
,, .	Aberdeen, Cranford Ho	6·59	167	223	*Gal .*	Galway, Waterdale ...	...	...	...
,, .	Fyvie Castle	3·05	77	...	,, .	Ballynahinch Castle ..	6·95	177	...
Mor .	Gordon Castle.....	3·20	81	100	*Mayo*	Mallaranny.....	6·15	156	...
,,	Grantown-on-Spey....	4·39	111	143	,, .	Westport House.....	4·47	113	144
Na .	Nairn, Delnies.....	3·43	87	128	,, .	Delphi Lodge	9·73	247	...
Inv..	Ben Alder Lodge	5·59	142	...	*Sligo*	Markree Obsy.	4·64	118	135
,, .	Kingussie, The Birches	3·69	94	...	*Ferm*	Enniskillen, Portora ..	3·86	98	...
,, .	Fort Augustus	4·08	104	146	*Arm.*	Armagh Obsy.	4·77	121	165
,, .	Loch Quoich, Loan....	12·00	305	...	*Down*	Warrenpoint	4·71	120	...
,, .	Glenquoich	10·22	260	159	,, .	Seaforde	5·68	144	178
,, .	Inverness, Culduthel R.	3·22	82	...	,, .	Donaghadee	3·19	81	114
,, .	Arisaig, Faire-na-Squir	5·61	143	...	,, .	Banbridge, Milltown .	3·94	100	121
,, .	Fort William.....	8·58	218	...	*Antr.*	Belfast, Cavehill Rd. ..	3·91	99	...
,, .	Skye, Dunvegan.....	4·79	122	...	,, .	Glenarm Castle.....	4·92	125	...
,, .	Barra, Castlebay	2·59	66	...	,, .	Ballymena, Harryville	5·76	146	168
R&C	Alness, Ardross Cas. ..	4·32	110	143	*Lon .*	Londonderry, Creggan	6·15	156	168
,, .	Ullapool.....	2·93	74	...	*Tyr .*	Donaghmore	5·51	140	...
,, .	Torridon, Bendamph..	6·42	163	118	,, .	Omagh, Edenfel	3·68	93	108
,, .	L. Carron, Plockton...	4·27	109	...	*Don .*	Malin Head	3·24	82	114
,, .	Stornoway	4·84	123	160	,, .	Rathmullen.....	4·63	118	...
Suth.	Lairg	3·27	83	...	,, .	Dunfanaghy	3·19	81	92
,, .	Tongue Manse.....	3·72	95	122	,, .	Narin, Kiltoorish	4·42	112	...
,, .	Melvich School.....	3·29	84	118	,, .	Killybegs Rockmount..	5·41	137	123

Climatological Table for the British Empire, February, 1924

STATIONS	PRESSURE		TEMPERATURE							Relative Humidity	Mean Cloud Am'nt	PRECIPITATION			BRIGHT SUNSHINE	
			Absolute		Mean Values				Mean							
	Mean of Day M.S.L.	Diff. from Normal	Max.	Min.	Max.	Min.	½ max. and min.	Diff. from Normal	Wet Bulb.			Am'nt	Diff. from Normal	Days	Hours per day	Percentage of possible.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0—10	mm.	mm.			
London, Kew Obsy.	1017·8	+ 1·8	51	24	42·4	33·5	37·9	— 2·2	36·6	79	7·6	11	— 28	8	1·3	13
Gibraltar	1014·7	— 5·3	64	38	58·7	47·8	53·3	— 2·6	49·0	76	6·7	385	+278	18	...	...
Malta	1011·5	— 3·5	69	43	59·6	50·7	55·1	+ 0·8	50·6	79	5·5	50	— 1	12	5·7	52
Sierra Leone	1011·6	+ 0·6	93	70	87·9	72·1	80·0	— 2·3	72·7	68	2·6	14	+ 7	1	...	...
Lagos, Nigeria	1008·5	— 1·6	93	72	91·2	77·1	84·1	+ 2·0	79·7	73	6·7	28	— 23	2	...	...
Kaduna, Nigeria	1012·5	+ 0·5	98	...	94·1	...	...	...	66·3	43	0·7	0	— 5	0	...	...
Zomba, Nyasaland	1009·4	+ 1·6	87	59	77·7	63·8	70·7	— 1·0	...	89	8·3	283	+ 7	19	...	...
Salisbury, Rhodesia	1009·4	— 0·5	85	50	77·8	57·3	67·5	— 1·4	60·9	65	4·9	46	—136	7	...	...
Cape Town	1014·3	+ 0·9	100	56	81·7	61·5	71·6	+ 1·6	65·5	62	2·8	Trace	— 15	1	...	...
Johannesburg	1014·0	+ 1·5	82	41	72·9	52·4	62·7	— 2·7	54·8	69	3·2	74	— 56	13	8·1	62
Mauritius	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Bloemfontein	...	...	91	45	81·1	57·1	69·1	— 2·8	58·8	62	4·0	34	— 54	8	...	...
Calcutta, Alipore Obsy.	1012·1	— 1·2	91	56	85·0	62·0	73·5	+ 2·5	61·6	80	1·7	17	— 12	2*	...	...
Bombay	1011·5	— 1·1	88	62	83·2	69·4	76·3	+ 0·7	66·2	70	1·9	0	— 1	0*	...	...
Madras	1012·0	— 0·9	92	63	87·2	68·1	77·7	0·0	71·7	80	1·9	0	— 8	0*	...	...
Colombo, Ceylon	1010·2	— 0·4	93	68	89·1	72·9	81·0	+ 0·4	76·7	66	6·6	68	+ 15	5	8·5	71
Hong Kong	1015·4	— 3·4	75	49	63·6	57·3	60·5	+ 1·4	57·9	86	9·3	115	+ 72	12	1·5	14
Sandakan	...	...	88	72	85·7	74·9	80·3	+ 0·2	76·5	78	...	339	+ 95	9	...	...
Sydney	1011·6	— 2·4	92	57	81·0	65·4	73·2	+ 2·0	66·1	65	5·2	59	— 57	13	7·1	53
Melbourne	1011·5	— 3·0	93	40	74·6	55·7	65·1	— 2·3	60·0	62	6·4	96	+ 52	15	6·3	48
Adelaide	1012·5	— 1·8	98	50	80·8	58·5	69·7	— 4·4	59·5	51	5·2	67	+ 50	11	7·5	57
Perth, W. Australia	1013·5	+ 0·4	99	54	85·0	62·5	73·7	— 0·3	63·2	53	3·1	3	— 9	3	9·5	72
Coolgardie	1012·6	+ 0·1	105	47	88·9	60·4	74·7	— 1·3	61·9	37	2·8	49	+ 30	5	...	...
Brisbane	1012·3	+ 0·1	96	65	86·2	70·8	78·5	+ 2·0	72·9	71	6·4	235	+ 70	14	7·1	54
Hobart, Tasmania	1010·0	— 3·5	78	43	66·1	53·2	59·7	— 2·7	54·5	69	7·4	86	+ 49	16	5·5	40
Wellington, N.Z.	1016·4	+ 1·1	75	51	70·9	59·5	65·2	+ 2·8	59·9	72	6·1	108	+ 25	10	7·4	54
Suva, Fiji	1009·2	+ 1·5	89	69	85·8	73·1	79·5	— 1·0	76·6	82	6·0	286	+ 29	22	...	...
Kingston, Jamaica	1016·2	+ 0·9	91	62	86·5	68·1	77·3	+ 0·8	69·5	66	4·8	9	— 6	4	...	...
Grenada, W.I.	1015·4	+ 2·0	85	68	82·8	71·3	77·1	+ 0·1	71·9	74	4·1	76	+ 4	17	...	...
Toronto	1019·6	+ 1·6	39	— 2	27·6	12·9	20·3	— 1·4	17·1	53	6·4	83	+ 17	15	4·2	40
Winnipeg	1024·7	+ 2·9	46	—22	22·0	2·1	12·1	+12·7	...	...	4·6	10	— 10	6	4·6	46
St. John, N.B.	1014·2	+ 0·1	37	— 3	24·1	8·5	16·3	— 3·6	13·2	58	5·3	52	— 47	7	5·6	54
Victoria, B.C.	1019·8	+ 3·9	53	35	49·4	40·9	45·1	+ 4·8	42·6	88	7·8	134	+ 44	20	3·1	31

* For Indian stations a rain day is a day on which 0·1 in. (2·5 mm.) or more rain has fallen.